

BROOKHAVEN






Brookhaven National Laboratory

Handbook on Chemical Use in Laboratories






(OSHA Laboratory Standard)




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General Rules for Laboratory Scale Use of Chemicals





1.	Conduct operations with hazardous chemicals in a functioning laboratory hood, glove box, or other engineering control setting. Do not conduct operations with hazardous chemicals on lab benches. Examples of operations with hazardous chemicals are reactions, pouring, evaporation, or other vapor, mist, fume, or dust-generating operations.	
2.	Limit work with hazardous chemicals on laboratory benches to operations such as opening packing boxes, preparing labels for containers, handling closed containers of chemicals, and preparing nonhazardous test media or equipment (i.e., <u>operations that do not have the potential to result in employee exposure to hazardous levels of chemicals</u>).	
3.	<p>Keep laboratory hoods free of excessive equipment and chemical storage containers.</p> <p>?? Handle chemicals at least 6 inches into the hood.</p> <p>?? Keep equipment, boxes, and bottles at least 6 inches from the front face of the hood. Do not obstruct the flow of air into the slot in the rear of the hood.</p> <p>?? Chemicals may be stored within the hood on elevated shelves or platforms (noncombustible material) that do not restrict the airflow within the hood. Do not store chemicals in hoods with sinks, unless provisions are made to prevent spillage from flowing into the sink.</p> <p>?? Do not insert your head into the hood when hazardous operations are conducted. Insert only appropriately protected hands and arms into hoods.</p> <p>?? Lower the sash to protect the eyes from a direct path to hazardous operations where splashes or impact could occur. Do not open "sash hoods" beyond the point indicated on the "face velocity test" sticker when conducting hazardous operations.</p> <p>?? Have your lab hood tested for "face velocity" annually.</p>	
4.	Provide engineering controls or additional ventilation for oven, autoclaves, gas chromatographs, mass spectrometers, and other equipment, if the process conducted within the apparatus causes hazardous levels of contaminants to be produced within the occupied laboratory space.	
5.	Do not bring or consume food and beverages in laboratory chemical-handling areas. Do not store food in chemical laboratory refrigerators. Do not store chemicals in break room and kitchen refrigerators.	
6.	Do not store bottles of corrosive chemicals (e.g., acids and bases) above eye level.	
7.	Do not mouth pipette chemicals. Use auto-pipeting devices or pipetters.	
8.	Use appropriate PPE to prevent eye and skin contact, ingestion, and inhalation. See the SBMS Personal Protective Equipment Subject Area.	

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7.	<p>Use a tray to surround a bottle or vessel to contain the hazardous liquids in the event of a spill or leak. This tray is referred to as secondary containment. It is not necessary to label the secondary containment unless its construction covers the label on the primary vessel.</p> <p>Note: Placing more than one container into the same tray is acceptable only if the chemicals are compatible.</p>	
8.	<p>Carcinogens must be labeled with warning that the chemical is a potential carcinogen. Examples of appropriate labels/signs are:</p> <div data-bbox="812 562 1198 751"><p>Carcinogen</p></div>	

Chemical Container Labeling in Laboratories

1.	<p>Do not remove or deface labels on containers (bottles, boxes, bags, drums) received from manufacturers and distributors unless they are replaced with a label that contains equivalent wording on the contents.</p> <p style="text-align: right;">Manufacturer's Label</p> <p>Note: Re-using a container once it has been cleaned is acceptable. In that case, it is acceptable and required to deface the original label.</p>	
2.	<p>Label stationary containers (e.g., tanks or vessels) in a laboratory with a label that identifies the name of the chemical within the vessel. Adding the hazards of the chemical (e.g., toxicity, fire hazard, reactivity, stability) is advisable.</p>	
3.	<p>When processes require the transfer of all or a portion of a chemical to a new container, <u>identify the chemical name</u> on the new container. Adding the hazard of the chemical (e.g., toxicity, fire hazard, reactivity, stability) is advisable.</p>	
4.	<p>Alternative Means of Labeling: Using codes or numbers on bottles or vessels as a means of labeling is permitted. There must be a logbook, laboratory record, sample sheet, or other written record of the codes or numbers that allows all users to know the contents of the container. All workers in the lab need to be familiar with the numbering technique so they can identify the contents.</p> <p><i>For example: If a bottle is labeled "6-JQP-123," its code name must link to the sixth lab book, the notebook must be numbered "6-JQP," and page 123 of that notebook must list information on the chemical.</i></p>	
5.	<p>Temporary Use Containers: When a container (e.g., bucket, bottle, or beaker) is filled for temporary use, it does not have to be labeled if all of the following apply:</p> <ul style="list-style-type: none"> ?? It will be used only by the person who has filled the temporary container; ?? There is no possibility for misidentification with other containers; ?? It will be not used beyond one shift; ?? It will not be left unattended in an area where other persons are located. <p>Examples of temporary use containers are chromatograph sample bottles, test tubes, daily use of graduated cylinders, beakers, volumetric flasks, and culture plates.</p>	
6.	<p>Guidance for Small Sample Vials and Ampoules: Individual labels on small containers may be impractical. Labeling a sample holder that holds numerous small containers of similar chemicals with a group label is permitted.</p>	


	<p>(100°F) and below 60°C (140°F).</p> <p>?? Class IIIA liquids include those having flash points at or above 60°C (140°F) and below 93°C (200°F).</p> <p>?? Class IIIB liquids include those having flash points at or above 93°C (200°F).</p>
compressed gas	Any mixture of gases in a container with an absolute pressure exceeding 40 psi at 70°F or 104 psi at 130°F, or a liquid having a vapor pressure exceeding 40 psi at 100°F.
corrosive	A material that causes destruction or alteration of human tissue at the site of contact.
cryogenic liquid	A refrigerated liquefied gas having a boiling point colder than -90°C (-130°F) at 101.3pKa (14.7 psi) absolute.
explosives	Chemicals that cause a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.
flammable gas	A gas that is flammable in a mixture of 13% or less (by volume) with air; or the flammable range with air is wider than 2 percent regardless of the lower limit.
flammable liquid	<p>A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lb. per sq. in. (absolute) (2068 mm Hg) at 100°F (37.8°C). Class I liquids are subdivided as follows:</p> <p>?? Class IA includes those having flash points below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C).</p> <p>?? Class IB includes those having flash points below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C).</p> <p>?? Class IC includes those having flash points below 73°F (22.8°C) and below 100°F (37.8°C).</p>
flammable solid	<p>A substance that is:</p> <p>?? Thermally unstable and can undergo a strongly exothermic decomposition even without participation of oxygen;</p> <p>?? Readily combustible and can cause a fire through friction, such as matches;</p> <p>?? Any material with a burning rate faster than 2.2 mm (0.087 in) per second;</p> <p>?? Any metal powder that can be ignited and react over the whole length of a sample in 10 minutes or less.</p>
irritant	Chemical that has a reversible inflammatory effect on living tissue.
organic peroxide	Compounds that release oxygen readily and are capable of violent or explosive decomposition when exposed to air.
oxidizer	A material that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.
permissible exposure limits (PELs)	Airborne concentrations of substances that represent conditions under which it is believed nearly all workers may be repeatedly exposed, daily, without adverse effects. PELs represent time-weighted average concentrations, usually expressed in units of mg/m ³ or parts per million (ppm) for an 8-hour workday within a 40-hour work week.
physical hazard	Any chemical that is combustible, explosive, flammable, pyrophoric, unstable (reactive), water reactive, a compressed gas, an organic peroxide, or an oxidizer.
pyrophoric	A chemical that will ignite spontaneously in the ambient atmosphere at or below 130°F.
reproductive toxin	Agents that affect the chromosomal structure of a cell or will adversely affect a

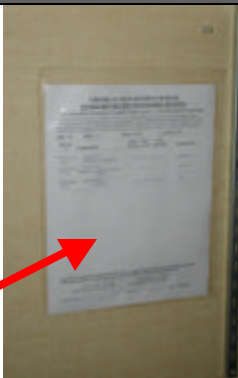
	developing fetus.
short-term exposure limit® (STEL®)	Amount of a chemical to be safely exposed to over a 15-minute period.
target organ toxin	Chemical that adversely affects a particular organ in the body.
threshold limit value® (TLV®)	A time-weighted average airborne concentration for a normal 8-hour work day and 40-hour work week to which nearly all workers may be repeatedly exposed without adverse effect. The Conference of Governmental Industrial Hygienists (ACGIH) adopts threshold limit values.
toxic chemical	<p>Chemical that can produce injury or illness to an individual through inhalation, dermal absorption, ingestion, or injection and that meets the following criteria:</p> <ul style="list-style-type: none"> ?? Oral LD-50 in white rats greater than 50 mg/kg but less than 500 mg/kg; ?? Dermal LD-50 in white rabbits greater than 200 mg/kg but less than 1000 mg/kg; ?? Inhalation LC-50 in white rats greater than 200 ppm but less than 2000 ppm (for gases or vapors) or greater than 2 mg/L but less than 20 mg/L (for dusts, fumes, or mists). <p>Chemicals that have a higher LD-50 or LC-50 are considered to be nontoxic for the purposes of monitoring.</p>
unstable (reactive)	Chemical that decomposes, condenses, or becomes self-reactive under conditions of shock, pressure, or temperature.
water reactive	Chemical that reacts with water to release a gas that is flammable, explosive, or a health hazard.

Chemical Management System (CMS) Inventories in Laboratories

Point of Contact: Chemical Management System

BNL requires that all chemicals are accounted for in the [Chemical Management System \(CMS\)](#). For additional guidance, see [What Chemicals Need to Be Inventoried in the CMS](#).

1.	<p>Chemical containers arriving on-site by the standard acquisition method are inventoried and bar coded when applicable at Receiving, Building 100, by the CMS Team. If manufacturer-labeled chemical containers are brought on-site by any other method, notify the CMS Team to have chemical containers inventoried and bar coded for inclusion in the CMS.</p>	
2.	<p>CMS Contact Persons are responsible for their chemical inventory and must ensure that chemicals in their area are used, stored, and inventoried properly. CMS Contact Persons also are responsible for ensuring that their inventory is accurately recorded and up-to-date by periodically accessing the Chemical Management System (CMS) to reconcile and update inventory. The CMS Team will generate reports when there has been no change or activity in the CMS Contact Person's inventory over prolonged periods.</p>	
3.	<p>CONTAINER DELETIONS When bar coded chemical containers are empty or designated for disposal, remove the bar code label and affix it to the Bar Code Label Removal Sheet. If the bar code label cannot be transferred to the Bar Code Label Removal Sheet, write in the bar code number and deface the bar code label before disposing of the container. Forward the Bar Code Label Removal Sheet to the CMS Team, Building 120. Bar Code Label Removal Sheets can be obtained from the CMS Team or from the Chemical Management System.</p>	
4.	<p>CONTAINER TRANSFERALS When transferring a bar coded chemical container to another room, researcher, or storage location, fill out the information on the Chemical Transfer Sheet. The new information includes the date, bar code number, contact person, organization code, building number, and room number. Do not remove the bar code label when transferring a chemical container. Forward the Chemical Transfer Sheet with the new information to the CMS Team, Building 120. Chemical Transfer Sheets can be obtained from the CMS Team or from the Chemical Management System.</p>	

5.	<p>STATIC INVENTORY</p> <p>Static Inventory is a classification reserved to track chemical quantities, but <u>not the individual container</u>. Chemical containers that experience a high turnover/high consumption rate or containers that are always exchanged for the same type and amount (e.g., gas cylinders, cleaning chemicals in bulk storage) may be designated as static. Under this category, chemicals are inventoried using the expected maximum amount of each substance found in the area at any given time.</p> <p>A Static Inventory Posting, containing the bar codes, is then posted in the area. The individual chemical containers are not bar coded.</p> <p>Do not remove the static inventory posting. If the amounts specified on the static inventory posting deviate significantly, exceed the maximum, or a change in process occurs, contact the CMS Team.</p>	
6.	<p>LABORATORY RELOCATION</p> <p>Chemical holdings are recorded in the CMS database under a specific building, room, and storage location. If your laboratory or shop is moving its operations to a new room or building, notify the CMS Team of the new location of the chemical containers. This information can be sent to the CMS Team by completing a Chemical Transfer Sheet or by contacting the CMS Team directly. The up-to-date information supplied is vital for maintaining data integrity. Chemical Transfer Sheets can be obtained from the CMS Team or from the Chemical Management System.</p>	
7.	<p>TERMINATING CMS CONTACT PERSONS</p> <p>Chemical holdings are also recorded in the CMS database under a specific organization, CMS Contact Person, and life number. The Human Resources Division notifies the CMS Team of upcoming employee terminations. The CMS Team then sends the terminating Contact Person and their ES&H Coordinator a report listing their assigned chemical inventory. The Contact Person is responsible for reconciling their chemical inventory before departing and notifying the CMS Team as to its final disposition. If you retire as an employee of the Laboratory and return as a guest, inform the CMS Team of your new guest number so that inventory can be updated accordingly.</p>	
8.	<p>TRANSFERRING CMS CONTACT PERSONS</p> <p>Before transferring to another Department/Division, notify the CMS Team as to your new organization, as well as the disposition of your chemical inventory. Notify the CMS Team when a "Request for Change in Employee Status" Form (BNL F 1081) is prepared for a person on the Contact Person List.</p>	

Personal Protective Equipment (PPE) in Laboratories

See the [Personal Protective Equipment](#) Subject Area for specific guidance on obtaining, using, maintaining, and disposing of PPE at BNL. Limit work with chemicals without PPE to operations that do not have the potential to result in employee exposure to hazardous levels of chemicals.

1. Eye Protection

- ?? Use safety glasses with side shields when handling any hazardous chemical.
- ?? Use splash-proof goggles or a full-face shield when pouring corrosive liquids (e.g., inorganic acids and bases).
- ?? Use vapor-proof goggles or a full-face respirator when handling highly toxic chemicals with the potential for vaporization or airborne particulate (outside of laboratory hoods or glove boxes).



2. Body Protection

- ?? Wear appropriate PPE when the potential for contamination of employee-owned clothing could occur. Laboratory-issued and laundered clothing may be used when handling hazardous chemicals when they provide adequate protection.
- ?? Wear Lab coats in laboratories when handling hazardous chemicals. Do not wear Lab coats used in hazardous chemical areas outside these areas.



3. Hand Protection

For operations where contact with the chemical does not pose a significant amount of time of contact with the chemical:


- ?? Nitrile and PVC elastomers typically offer superior permeation protection over natural rubber gloves. If contact with the chemical actually occurs, immediately stop the operation, and remove and dispose the glove. (**Note:** Nitrile and PVC are free of latex sensitization hazards. Non-talc natural rubber is less hazardous.)
- ?? Natural rubber gloves (e.g., surgeon or medical exam gloves) may be used for operations when handling chemicals with low toxicity (where contact with the chemical does not pose a significant risk).







For operations where there is the potential for significant contact with hazardous chemicals:




- ?? Select appropriate gloves based on acceptable permeation rate, breakthrough time, degradation, and dexterity. Typical operations in this class include immersion of gloves into liquids, pouring large quantities of liquids, handling large quantities of corrosive or highly toxic powders, or handling concentrated inorganic acids and bases. These gloves may be reused if properly decontaminated before storage.



<p>4.</p>	<p>Foot Protection</p> <ul style="list-style-type: none"> ?? Wear safety-toed shoes when the handling of chemical drums or large packages of chemicals could cause foot injury. ?? Sandals and open-toe shoes are prohibited in laboratories at all times. ?? When handling cryogenic liquids, refer to ES&H Standard 4.10.2, Flammable Liquids: Storage, Use, and Disposal and ES&H Standard 5.1.0, Nonflammable Cryogenic Liquids for information on hand and eye protection. 
<p>5.</p>	<p>In the Event of Chemical Exposure to the Skin:</p> <ul style="list-style-type: none"> ?? Immediately remove contaminated garment. ?? For small areas of skin contamination: Remove contaminated clothing. Wash the skin thoroughly with water. ?? For large areas of skin contamination: Remove contaminated clothing. Wash the area thoroughly in a safety shower. Call (or have someone else call) 911 for assistance. ?? Report all chemical exposures to the Occupational Medicine Clinic in Building 490. <p>Note: Consider bringing in some seldom-used clothes (pants, socks, and shirt) and keep them handy in case of this type of event.</p>
<p>6.</p>	<p>In the Event of a Chemical Inhalation Exposure:</p> <p>Leave the area and immediately call 911 for assistance.</p>

Chemical Storage in Laboratories

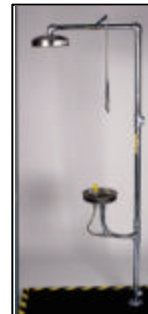
1.	<p>Flammable and combustibles (See ES&H Standard 4.10.2, Flammable Liquids: Storage, Use, and Disposal):</p> <ul style="list-style-type: none"> ✂ Minimize quantities to an amount that is adequate for day-to-day operations. ✂ Store large quantities in an NFPA-approved flammable storage cabinet. ✂ Store away from oxidizers. ✂ Do not store in ordinary refrigerators. A spark from the motor or light switch can ignite such a substance. ✂ Use only in well-ventilated area. ✂ Remove all heat and ignition sources from the area. ✂ Keep containers closed when not in use. ✂ Check containers regularly for leaks. ✂ Ground large containers before transferring liquids from metal containers. 	
2.	<p>Storage of any material (other than water) in aboveground or underground tanks or portable containers ≥ 250 gallons is covered by the requirements found in the Storage and Transfer of Hazardous Materials Subject Area.</p>	
3.	<p>Do not store hazardous chemicals over sinks where breakage could cause entry into the sanitary system.</p>	
4.	<p>Segregate chemicals in storage to prevent incompatibility in flammability and reactivity in the event of accidental breakage. Refer to Examples of Incompatible Chemicals in the Hazardous Waste Management Subject Area, and sections "Explosive Materials" and "Peroxide-Forming Compounds" in this Handbook.</p>	
5.	<p>Store chemicals known to be highly toxic, including those classified as carcinogens, in ventilated storage areas and in unbreakable, chemically resistant secondary containers. Post the storage areas for these chemicals with warning and limited access signs.</p>	
6.	<p>Do not store acids and caustic liquids above eye level. A typical storage location for these types of corrosive liquids is a base cabinet under a sink or a special acid storage cabinet.</p>	
7.	<p>Avoid exposing chemicals to heat or sunlight.</p>	

8.	Store chemicals in cabinets or shelves when not in use. Toe boards (0.5 inch high lips on the front of the shelf) on shelves lessen the chance of accidentally dislodging bottles from the shelf. (Cabinets with metal shelves can often be converted into shelves with toe boards [lips] by turning the shelves over to place the metal structural support upwards).	
9.	Do not place food in laboratory refrigerators. Laboratory refrigerators are to be used for storage of chemicals only. Place a label on the refrigerator stating "No Food Permitted."	
10.	Avoid excessive use of lab bench as a storage area to prevent crowding and the potential for breakage of bottles during routine work on the bench.	
11.	Keep storage of chemicals in laboratory hoods to a minimum. Chemicals may be stored within the hood on elevated shelves or platforms (noncombustible material) that do not restrict the airflow within the hood.	
12.	Do not store chemicals by mere alphabetical order without regard to the class and hazard of the chemicals. Sort and store by hazard and chemical class.	
13.	Use storage trays or secondary containers to minimize the distribution of the spill should a container break or leak. In the event of a major spill, evacuate the area and from a safe location and call 911 for the BNL Emergency Services Division response team. For more guidance, see the Emergency Preparedness and Spill Response Subject Areas.	

Eyewash Equipment & Emergency Showers in Laboratories

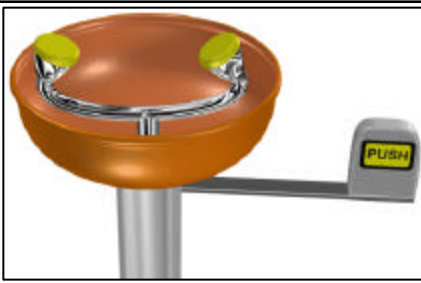

The use of corrosive and hazardous chemicals necessitates that emergency response capabilities are in place to ensure worker safety in the event of an accidental exposure. The following guidelines ensure that equipment is ready and functioning in the event of an emergency. This includes equipment for the quick and complete drenching or flushing of the eyes and body in an emergency situation.

BNL's goal is compliance with OSHA 29 CFR 1910.151, OSHA 29 CFR 1910.1450, and the principles in ANSI Z358.1. To meet this objective, the following guidelines on design and periodic testing are to be followed:



1.	In any laboratory where <u>corrosive materials</u> or <u>formaldehyde</u> could potentially injure the eyes or body, provide equipment for quick drenching or flushing of the eyes and body (e.g., eyewash equipment and emergency showers).
2.	<p>Design:</p> <p>(a.) New equipment purchases must meet the current design specifications in ANSI Z358.1. Units are to be installed within manufacturer's installation specifications.</p> <p>(b.) Existing equipment should be upgraded to (2.a.) or replaced if its current design is not capable of drenching or flushing the eyes and body in an emergency situation.</p> <p>(c.) Self-contained and portable eyewash stations must be serviced according to manufacturer's instructions. Limit use of self-contained and portable eyewash stations to areas where plumbed units are not feasible. The IH Representative must authorize use of a self-contained or portable eyewash station based on a hazard evaluation that demonstrates the equipment will provide adequate protection and that maintenance procedures are in place.</p>
3.	<p>The optimal design for plumbed Emergency Showers includes the following:</p> <ul style="list-style-type: none"> ?? 82-inch clearance from floor (208 cm); ?? Spray pattern 20 inches (50.8 cm) at 60 inches (154.2 cm); ?? Center of spray 16 inches (40.6 cm) from any obstruction; ?? Capable of delivery of 20 gpm (75.7 lpm); ?? Sufficient liquid for 15-minute flow; ?? Valve designed to remain on without use of operator's hands; ?? Valve remains on until intentionally shut off; ?? Valve operates from "off" to "on" in 1 second or less; ?? Actuator not more than 69 inches (173.3 cm) above the level of the user's feet; ?? Accessible location no more than 10 seconds; ?? Located on the same floor level as the hazard; ?? Shower free of obstructions that inhibit immediate use of equipment; ?? Freeze-protected; ?? Identified by high visibility sign; ?? Flushing fluid delivery tepid.



<p>4.</p>	<p>The optimal design for plumbed Eyewash Equipment includes the following:</p> <ul style="list-style-type: none"> ?? Controlled flow to both eyes simultaneously; ?? Flow not injurious to eyes; ?? Nozzles protected from airborne hazards; mechanisms do not require a separate motion to remove; ?? Enough room provided to allow eyelids to be held open with hands; ?? Nozzles between 33 inches (83.3 cm) and 45 inches (114.3 cm) from floor; ?? Nozzles a minimum of 6 inches (15.3 cm) from nearest wall or obstruction; ?? Capable of delivery of 0.4 gpm (1.5 lpm); ?? Sufficient liquid for 15-minute flow; ?? Valve designed to remain on without use of operator's hands; ?? Valve shall remain on until intentionally shut off; ?? Valve operates from "off" to "on" in 1 second or less; ?? Accessible location no more than 10 seconds away; ?? Located on the same level as the hazard, path free of obstructions that inhibit immediate use of equipment; ?? Shower free of obstructions that inhibit immediate use of equipment; ?? Freeze-protected; ?? Identified by high visibility sign; ?? Flushing fluid delivery tepid. 	
<p>5.</p>	<p>Periodic Testing</p> <p>(a.) In laboratories with corrosive chemicals or formaldehyde, <u>activate</u> eyewash equipment <u>weekly</u>. Have plumbed eyewash equipment and emergency showers inspected <u>annually</u> to assure ANSI Z-358.1 conformance.</p> <p>(b.) In laboratories with hazardous chemicals, <u>activate</u> eyewash equipment at least every <u>3 months</u>. Have plumbed eyewash equipment and emergency showers inspected <u>annually</u> to assure ANSI Z-358.1 conformance.</p> <p>Post the Eye Wash Activation/Inspection Sign (or use an equivalent method) to ensure the periodic activation and inspection testing of equipment.</p> <p>Verify that the <i>BNL Inspection Office Inspection Tag</i> for eyewash equipment and emergency showers indicates that the equipment has been inspected.</p>	

Example of an Eye Wash Activation/Inspection Sign or Label

Eye Wash used for Corrosive Chemicals or Formaldehyde:



Eye Wash used for HazCom Areas with non-corrosive chemicals:



Specific Chemical Hazards

Explosive Materials

Acetylides of heavy metals Aluminum ophorite explosive Ammonium nitrate explosive mixtures Aromatic nitro-compound explosive mixtures Ammonium perchlorate having particle size less than 15 microns Ammonium picrate ANFO (ammonium nitrate-fuel oil) BAEF (1,2-bis (2,2-difluoro-2-nitroacetoxyethane) Black powder Blasting agents, nitro-carbo-nitrates BTNEC (bis (trinitroethyl) carbonate) BTNEN (bis (trinitroethyl) nitramine) BTNN (1,2,4 butanetriol trinitrate) Butyl tetryl Calcium nitrate explosive mixture Copper acetylide Cyanuric triazide Cyclotrimethylenetrinitramine Cyclotetramethylenetetranitramine Cyclotol Diaminotrinitrobenzene Diazodinitrophenol Diethyleneglycol dinitrate Dinitroethyleneurea Dinitroglycerine Dinitrophenol Dinitrophenolates Dinitrophenyl hydrazine Dinitroresorcinol Dipicryl sulfone Dipicryl amine DNBP (dinitropentano nitrile) DNPA (2,2-dinitropropyl acrylate)	Dynamite EDNP (ethyl 4,4-dinitropentanoate) Erythritol tetranitrate explosives Esters of nitro-substituted alcohols EGDN (ethlyene glycol dinitrate) Ethyl tetryl Fulminates of mercury, gold, silver, platinum Guanyl nitrosamino guanyl tetrazene Guanyl nitrosamine guanylidene hydrazine Heavy metal azides Hexanitrodiphenylamine Hexanitrostilbene Hydrazoic acid KDNBF (potassium dinitrobenzo-furoxane) Lead azide Lead mannite Lead mononitroresorcinol Lead picrate Lead styphnate Magnesium ophorite Mannitol hexanitrate MDNP (metyl 4,4-dinitropentanoate) Mercury oxalate Mercury tartrate NIBTN (nitroisobutametrial trinitrate) Nitrogen trichloride Nitrogen tri-iodide Nitroglycerin Nitroglycide Nitroglycol Nitrostarch Nitrourea Organic nitramines Organic peroxides Picramic acid and its salts	Picramide Picratol Picric acid Picryl chloride Picryl fluoride Potassium nitroaminotetrazole Silver acetylide Silver azide Silver oxalate Silver styphnate Silver tartrate Silver tetrazene Sodium amatol Sodium dinitro-ortho-cresolate Sodium picramate Styphnic acid TATB (triaminotrinitrobenzene) TEGDN (triethylene glycol dinitrate) Tetrazene Tetranitrocarbazole Tetryl (2,4,6 tetranitro-N-metylaniline) TMETN (trimetylolethane trinitrate) TNEF (Trinitroethyl formal) TNEOC (trinitroethylorthocarbonate) TNEOF (trinitroethyl orthoformate) TNT (trinitrotoluene) Trinitroanisole Trinitrobenzene Trinitrobenzoic acid Trinitrocresol Trinitro-meta-cresol Trinitronaphthalene Trinitrophenetol Trinitrophloroglucinol Trinitro resorcinol Urea nitrate
Main Hazard	Release of harmful pressure on shock or exposure to ignition source.	
First Aid	<p>Immediately call 911. Begin immediate and continuous flushing with water until Fire Rescue transports to a hospital. Remove potentially contaminated clothing during the flushing.</p> <p>For minor skin contact during working hours (e.g., limited exposure to fingers): Begin immediate and continuous flushing with water and call OMC at x-3670. Follow their instructions. Remove potentially contaminated clothing during the flushing.</p> <p>For inhalation, immediately call 911. Move to fresh air. Fire Rescue transports to a hospital.</p>	
Special Provisions	?? Do not work alone. ?? Identify the location of explosives on the <u>Fire Rescue Run Card System</u> and Green Hazard Information Placard at doorways.	
Work Planning and Control Documentation (Work Permit or ESR)	Work Planning and Control Documentation (Work Permit or ESR) must specifically address how PPE, Spill Response, First Aid, and the special provisions of this section are met.	

Spill Response Prerequisites	Evacuate area. Call 911. Do not attempt clean-up of concentrated acid.
Personal Protective Equipment Prerequisites	Faceshield required.

Specific Chemical Hazards

Hydrofluoric Acid

Main Hazard	Hydrofluoric Acid (HF) causes severe skin burns (often painless). Two percent solutions can cause burns. HF deeply penetrates before disassociating. Burns may involve underlying bone. Systemic fluoride ion poisoning from severe burns is associated with low calcium, high potassium, and low magnesium in blood, and sudden death. Inhalation can cause fluid in the lungs and severe respiratory burns.
First Aid	<p>Immediately call 911. Begin immediate and continuous flushing with water until Fire Rescue transports to a hospital. Remove potentially contaminated clothing during the flushing.</p> <p>For minor skin contact during working hours (e.g., limited exposure to fingers): Begin immediate and continuous flushing with water and call OMC at x-3670. Follow their instructions. Remove potentially contaminated clothing during the flushing.</p> <p>For inhalation: Immediately call 911. Move to fresh air. Fire Rescue transports to a hospital.</p>
Special Provisions	<p>?? Where HF is used, an eye wash station and shower must be within the immediate area.</p> <p>?? HF Burn Kits (or worksite calcium gluconate gel) are not recommended. The OMC-approved method of treatment is immediate and continual flushing with water followed by medical attention.</p> <p>?? No working alone.</p> <p>?? Identify the location of HF on the <u>Fire Rescue Run Card System</u> and Green Hazard Information Placard at doorways.</p>
Work Planning and Control Documentation (Work Permit or ESR)	Work Planning and Control Documentation (Work Permit or ESR) must specifically address how PPE, Spill Response, First Aid, and the Special provisions of this section are met.
Storage	Store with mineral acids (except Sulfuric Acid). Do not store with organic material. Do not transfer concentrated acid to glass or metal containers.
Spill Response Prerequisites	Evacuate area. Call 911. Do not attempt clean-up of concentrated acid.
Personal Protective Equipment Prerequisites	<p>Gloves: Splash: Nitrile disposable glove; Immersion: PVC, Neoprene are required.</p> <p>Lab coat or long-sleeved shirt is required.</p> <p>Faceshield required when pouring concentrated acid.</p>

Specific Chemical Hazards

Metallic Azides

Hazard	Hazard: explosive Uses: Plating with metals like lead.
Special Provisions	<ul style="list-style-type: none"> - Labeling of hoods; - Wash down systems; - Decontamination Plan must be addressed in Work Planning and Control documentation.
Work Planning and Control Documentation (Work Permit or ESR)	Work Planning and Control Documentation (Work Permit or ESR) must specifically address how all special provisions of this section are met.
Engineering Controls Prerequisites	Unless process knowledge of the entire history is known, contact the IH Representative for testing. Ventilation equipment that is contaminated by testing will be labeled with the date and "Azide Contaminated."
Equipment Monitoring Prerequisites	Use of Azide acid (above 100 mg per year) must be done in a specifically designed hood with a "wash down system," unless there is permission within the Work Planning review process with concurrence of Working With Chemicals SME.
	Testing of surface contamination is required: <ul style="list-style-type: none"> o At demolition or modification of any hood or local exhaust duct, o On an annual basis while Azides are in use (above 100 mg per year), o At the end of a project that used Azides.

Specific Chemical Hazards

Perchlorates/Perchloric Acid

Use of perchloric acid can create deposits of highly explosive metal perchlorates in hoods, ducts, fan housing, and other system components. Hammering, banging, and parts disassembly can result in very hazardous explosion and subsequent injury of maintenance or construction personnel. To prevent this hazard, requirements and limitations on perchloric acid use in exhaust systems are made. In particular, when perchloric acid is used in quantities that can create the explosion hazard in the exhaust system, all work must be done in specifically designed "perchloric acid/ perchlorate" hoods with wash down systems.

Special Provisions	<ul style="list-style-type: none"> - Surface wipe sampling; - Labeling of hoods; - Wash down systems; - Decontamination Plan must be addressed in Work Planning and Control documentation.
Work Planning and Control Documentation (Work Permit or ESR)	Work Planning and Control Documentation (Work Permit or ESR) must specifically address how all Special Provisions of this section are met.
Engineering Controls Prerequisites	<p>A. Quantitative Surface Wipe analysis is required for all lab hoods and exhaust ventilation equipment, unless process knowledge of the entire history of the equipment can verify that perchlorates/perchloric acid were never used in the system. Equipment that by process knowledge is known to be non-contaminated does not need to be tested.</p> <p>B. Unless process knowledge of the entire history is known, contact the IH Representative for testing. Ventilation equipment found to be contaminated by testing is labeled with the date and "Perchlorate Contaminated." Develop a plan for future action with the IH Representative. Copy to IH SOP.</p>
Equipment Monitoring Prerequisites	<p>Use of perchloric acid (above 10 ml per year) must be done in specifically designed hood with a "wash down system" unless there is permission within the Work Planning review process with concurrence of Working With Chemicals SME.</p> <p>Testing of surface contamination is required:</p> <ul style="list-style-type: none"> o Before demolition or modification of any hood or local exhaust duct, o On an annual basis while perchloric acid are in use (above 10 ml per year), o At the end of a project or work that used perchloric acid.

Specific Chemical Hazards

Peroxide-Forming Compounds

General Hazard	<p>?? Peroxides form in solvents, reagents, gases, and solids by the autoxidation or peroxidation of a peroxidizable compound with molecular oxygen. This hazard can be insidious and has caused many accidents.</p> <p>?? Peroxides in solution at concentrations up to about one percent do not normally present thermal or shock hazards. Such solutions may be safely disposed of or treated to remove peroxides. However, should crystals form in a peroxidizable liquid or discoloration occur in a peroxidizable solid, peroxidation may have occurred and the product should be considered extremely dangerous and should be destroyed without opening the container. Contact your Department ES&H Coordinator for assistance in arranging for disposal through the Waste Management Division.</p>																						
Materials Likely to Form Peroxides in Storage- List A	<p>LIST A: Severe Peroxide Hazard on Storage With Exposure to Air List A presents the most hazardous peroxidizable solvents. These compounds may explode even without being concentrated. Affix date label upon receipt and test for peroxide within three months of receipt. Contact ES&H Coordinator if tested positive. Re-date material if tested negative.</p> <p>?? Diisopropyl ether (isopropyl ether) ?? Divinyl acetylene (DVA) ?? Divinyl ether ?? Vinylidene chloride (1,1-dichloroethylene)</p>																						
Materials Likely to Form Peroxides in Storage- List B	<p>LIST B: Peroxide Hazard on Concentration. Observe Proper Precautions Before Distilling or Evaporating. List B contains solvents that form peroxides that require concentration (such as through distillation or evaporation) in order to present a hazard. Affix date label upon receipt and test for peroxide within 12 months of opening. Contact ES&H Coordinator if tested positive at a level greater than or equal to 100 ppm. Re-date material if tested negative or below 100 ppm.</p> <table border="0" style="width: 100%;"> <tr> <td>?? Acetal (diethyl acetal)</td><td>?? Ethylene glycol dimethyl ether (glyme) Ethyleneglycol ether acetates</td></tr> <tr> <td>?? Cumene (isopropyl benzene)</td><td>?? Ethylene glycol monoethers (cellosolves)</td></tr> <tr> <td>?? Cyclohexene</td><td>?? Furan</td></tr> <tr> <td>?? Cyclooctene</td><td>?? Methyl acetylene</td></tr> <tr> <td>?? Cyclopentene</td><td>?? Methylcyclopentane</td></tr> <tr> <td>?? Decalin (decahydronaphthalene)</td><td>?? Methyl isobutyl ketone</td></tr> <tr> <td>?? Diacetylenes (butadiyne, etc.)</td><td>?? Tetrahydrofuran (THF)</td></tr> <tr> <td> Dicyclopentadiene</td><td>?? Tetralin (tetrahydronaphthalene)</td></tr> <tr> <td>?? Diethyl ether (ether)</td><td>?? Vinyl ethers</td></tr> <tr> <td>?? Diethylene glycol dimethylether (diglyme)</td><td></td></tr> <tr> <td>?? Dioxane (p-dioxane, 1,4-dioxane)</td><td></td></tr> </table>	?? Acetal (diethyl acetal)	?? Ethylene glycol dimethyl ether (glyme) Ethyleneglycol ether acetates	?? Cumene (isopropyl benzene)	?? Ethylene glycol monoethers (cellosolves)	?? Cyclohexene	?? Furan	?? Cyclooctene	?? Methyl acetylene	?? Cyclopentene	?? Methylcyclopentane	?? Decalin (decahydronaphthalene)	?? Methyl isobutyl ketone	?? Diacetylenes (butadiyne, etc.)	?? Tetrahydrofuran (THF)	Dicyclopentadiene	?? Tetralin (tetrahydronaphthalene)	?? Diethyl ether (ether)	?? Vinyl ethers	?? Diethylene glycol dimethylether (diglyme)		?? Dioxane (p-dioxane, 1,4-dioxane)	
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Materials Likely to Form Peroxides in Storage- LIST C	<p>LIST C: Hazard of Rapid Polymerization Initiated by Internally Formed Peroxides^{1, 2}</p> <p>List C is made up of vinyl monomers which may form internal peroxides that can then initiate rapid polymerization of the bulk monomers. (Affix date label upon receipt and test for peroxide within 12 months of opening.) Contact ES&H Coordinator if tested positive at a level greater than or equal to 100 ppm. Re-date material if tested negative or below 100 ppm.</p> <ul style="list-style-type: none"> ?? Acrylic acid ?? Acrylonitrile ?? Chloroprene (2-chloro-1,3-butadiene) ?? Methyl methacrylate ?? Styrene ?? Vinyl acetate ?? Vinylpyridine ?? Vinylidene chloride <p>¹ Store Polymerizable monomers with a polymerization inhibitor from which the monomers can be separated by distillation just before use.</p> <p>² Although common acrylic monomers, such as acrylonitrile, acrylic acid, ethyl acrylate, and methyl acrylate can form peroxides, they have not been reported to develop hazardous levels in normal use and storage.</p>
Materials Likely to Form Peroxides in Storage - Peroxidizable Gases	<p>Peroxidizable Gases</p> <p>The following gases pose a potential hazard of rapid polymerization initiated by internally formed peroxides:</p> <ul style="list-style-type: none"> ?? Butadiene ?? Chlorotrifluoroethylene ?? Methylacetylene (propyne) ?? Tetrafluoroethylene (TFE) ?? Vinylacetylene ?? (MVA) Vinylchloride <p>Although air will not enter a gas cylinder in which gases are stored under pressure, these gases are sometimes transferred from the original cylinder to another in the laboratory, and it is difficult to be sure that there is no residual air in the receiving container. Put an inhibitor into any such secondary cylinder before one of these gases is transferred into it; the supplier can suggest inhibitors to be used. The hazard posed by these gases is much greater if there is a liquid phase in such a secondary container, and even inhibited gases that have been put into a secondary container under conditions that create a liquid phase should be discarded within 12 months.</p>
Materials Likely to Form Peroxides in Storage- Reactive, Oxidizable Solids	<p>Reactive, Oxidizable Solids</p> <ul style="list-style-type: none"> ?? Potassium (K) ?? Potassium Amide (KNH₂) ?? Sodium (Na) ?? Sodium Amide (NaNH₂) <p>Store and handle these highly reactive materials only under a hydrocarbon solvent (e.g., hexane, xylene, mineral oil). Avoid all contact with water or humid air, since the hydrogen gas released upon reaction with water can cause a fire. Reaction of sodium with oxygen forms sodium peroxide (Na₂O₂), and reaction of potassium with oxygen forms superoxide (KO₂), but these can not be tested by the conventional peroxide tests.</p>
Special Provisions	Labeling

	All compounds in Lists A, B, and C must bear the dates when the containers were first received and opened. The individual laboratory researcher affixes the appropriate information on the label upon receipt or delivery of the chemical.
Special Provisions	<p>Inventory Control</p> <p>Each supervisor responsible for a laboratory ensures all List A compounds are tested or properly disposed within three months of opening or receipt (whichever occurs first), and all List B and C compounds are tested or properly disposed within 12 months of opening. All compounds addressed by this section must continue to be tested on the same schedule (every three or 12 months) once they are initially tested. If any List A compound tests positive for peroxide at any level, or if any List B or C compound tests positive for peroxide at or above a level of 100 ppm (0.01%), the Department ES&H Coordinator must be contacted for guidance. All materials testing below these levels must be re-dated with this information on their label.</p>
Special Provisions	<p>Distillation and Evaporation Precautions</p> <p>?? Test all List A or B compounds for peroxide before distillation or evaporation (or treated to positively ensure peroxide destruction). If the material tests positive, it must be disposed of or treated to remove the peroxides. Add a suitable polymerization inhibitor before distilling any List C material.</p> <p>?? Most accidents associated with distillation of peroxidizable compounds have occurred when peroxides have become concentrated in the distillation residue. It is therefore essential to never distill a peroxidizable solvent to a dry residue. One solution for compounds showing no more than a trace of peroxide on testing is to discontinue the distillation when a 10% heel remains. Another solution is to add a high molecular, weight-inerting solvent that will not distill, such as mineral oil or a phthate ester. This solvent will act as a desensitizing diluent for residual peroxides when distillation is complete.</p> <p>?? In addition to safety glasses, use a shield when evaporating or distilling mixtures that may contain peroxides.</p>
Special Provisions	<p>Detection of Peroxides</p> <p>The following tests can detect most (but not all) peroxy compounds, including all hydroperoxides (Reference: "Prudent Practices in the Laboratory," National Research Council, National Academy Press, Washington, D.C., 1995):</p> <ol style="list-style-type: none"> Add 1 to 3 milliliters (ml) of the liquid to be tested to an equal volume of acetic acid, add a few drops of 5% aqueous potassium iodide solution, and shake. The appearance of a yellow-to-brown color indicates the presence of peroxides. Alternatively, addition of 1 ml of a freshly prepared 10% solution of potassium iodide to 10 ml of an organic liquid in a 25-mL glass cylinder should produce a yellow color if peroxides are present. Add 0.5 ml of the liquid to be tested to a mixture of 1 ml of 10% aqueous potassium iodide solution and 0.5 ml of dilute hydrochloric acid to which a few drops of starch solution have been added just before the test. The appearance of a blue or blue-black color within a minute indicates the presence of peroxides. Peroxide test strips, which turn to an indicative color in the presence of peroxides, are available commercially. Note that these strips must be air-dried until the solvent evaporates and then exposed to moisture for proper operation. <p>None of these tests should be applied to materials (such as metallic potassium)</p>

	that may be contaminated with inorganic peroxides.
Work Planning and Control Documentation (Work Permit or ESR)	Work Planning and Control Documentation (Work Permit or ESR) must specifically address how all special provisions of this section are met.
Labeling	Containers are labeled with most recent of "Received Date," "Opened Date," or "Tested Date" (or equivalent record log).
Waste Disposal Prerequisites	Prior to submitting a Nonradioactive Waste Control Form , the container is tested within the last 12 months. Notify WMD on the Nonradioactive Waste Control Form of containers that cannot be tested.
Removal of Peroxides	<p>The following guidance is from "Prudent Practices in the Laboratory," National Research Council, National Academy Press, Washington, D.C., 1995.</p> <p>a) Overview and Caution (CAUTION: Peroxides are particularly dangerous. Only knowledgeable laboratory workers should carry out these procedures.) Peroxides can be removed from a solvent by passing it through a column of basic activated alumina, by treating it with indicating Molecular Sieves, or by reduction with ferrous sulfate. Although these procedures remove hydroperoxides, which are the principle hazardous contaminants of peroxide-forming solvents, they do not remove dialkyl peroxides, which may also be present in low concentrations. Commonly used peroxide reagents, such as acetyl peroxide, benzoyl peroxide, t-butyl hydroperoxide, and di-t-butyl peroxide, are less dangerous than the adventitious peroxides formed in solvents.</p> <p>b) Removal of Peroxides with Alumina A 2x33 cm column filled with 80 g of 80-mesh basic activated alumina is usually sufficient to remove all peroxides from 100 to 400 ml of solvent, whether water-soluble or water-insoluble. After passage through the column, test the solvent for peroxide content. Peroxides formed by air oxidation are usually decomposed by the alumina, not merely absorbed on it. However, for safety, it is best to slurry the wet alumina with a dilute acidic solution of ferrous sulfate before it is properly discarded.</p> <p>c) Removal of Peroxides with Molecular Sieves Reflux 100 ml of the solvent with 5 g of 4- to 8-mesh indicating activated 4A Molecular Sieves for several hours under nitrogen. The sieves are separated from the solvent and require no further treatment because the peroxides are destroyed during their interaction with the sieves.</p>

	<p>d) Removal of Peroxides with Ferrous Sulfate</p> <p>A solution of 6 g of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, 6 ml of concentrated sulfuric acid, and 11 ml of water is stirred with 1 L of water-insoluble solvent until the solvent no longer gives a positive test for peroxides. Usually only a few minutes are required.</p> <p>Dialkyl peroxides can be destroyed by this reagent as well as by aqueous sodium hydrogen sulfate, sodium hydroxide, or ammonia. However, diacyl peroxides with low solubility in water, such as dibenzoyl peroxide, react very slowly. A better reagent is a solution of sodium iodide or potassium iodide in glacial acetic acid.</p>
	<p>e) Destruction of Diacyl Peroxides</p> <p>For 0.01 mol of diacyl peroxide, 0.022 mol (10% excess) of sodium or potassium iodide is dissolved in 70 ml of glacial acetic acid, and the peroxide added gradually with stirring at room temperature. The solution is rapidly darkened by the formation of iodine. After a minimum of 30 minutes, the solution may be properly discarded.</p> <p>Most dialkyl peroxides (ROOR) do not react readily at room temperature with ferrous sulfate, iodide, ammonia, or the other reagents mentioned above. However, these peroxides can be destroyed by a modification of the iodide procedure.</p>
	<p>f) Destruction of Dialkyl Peroxides</p> <p>One milliliter of 36% (w/v) hydrochloric acid is added to the above acetic acid/potassium iodide solution as an accelerator, followed by 0.01 mol of the dialkyl peroxide. The solution is heated to 90 to 100°C on a steam bath over the course of 30 minutes and held at that temperature for 5 hours, before being properly discarded.</p>